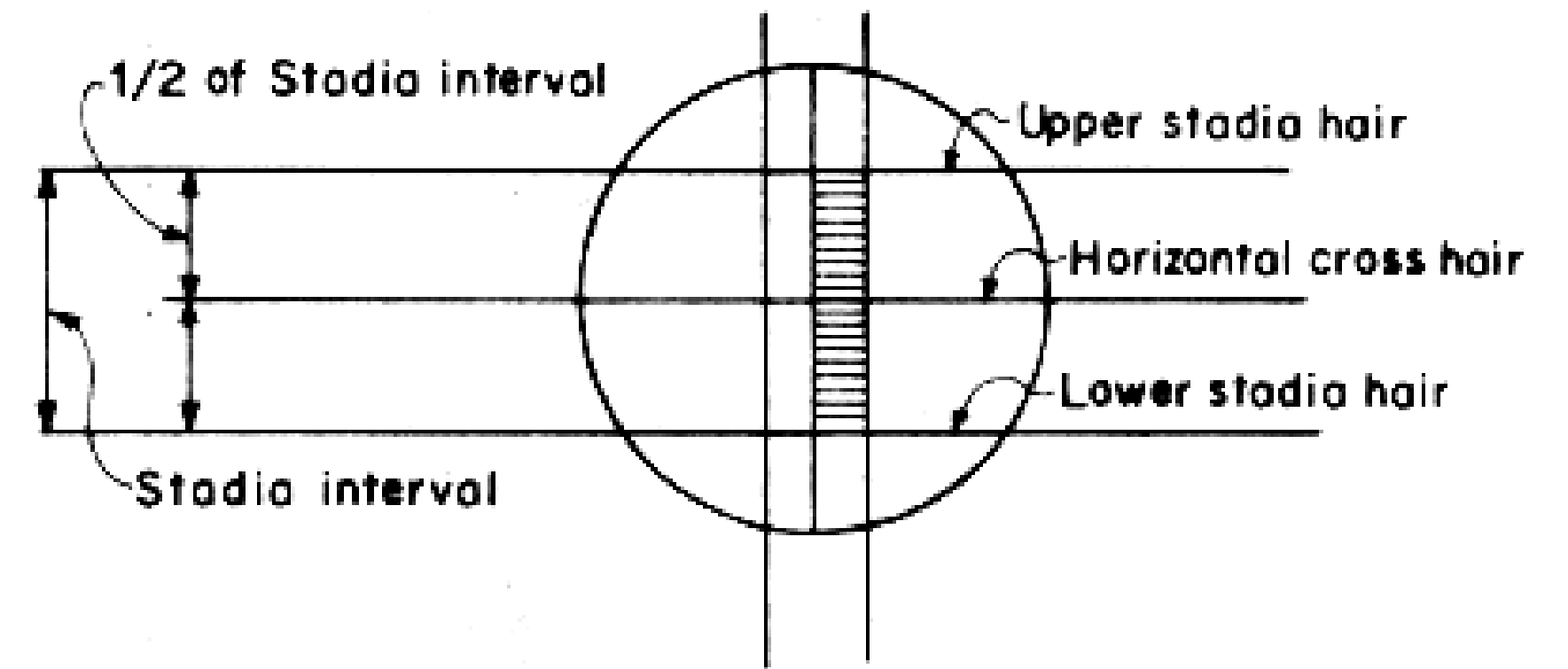
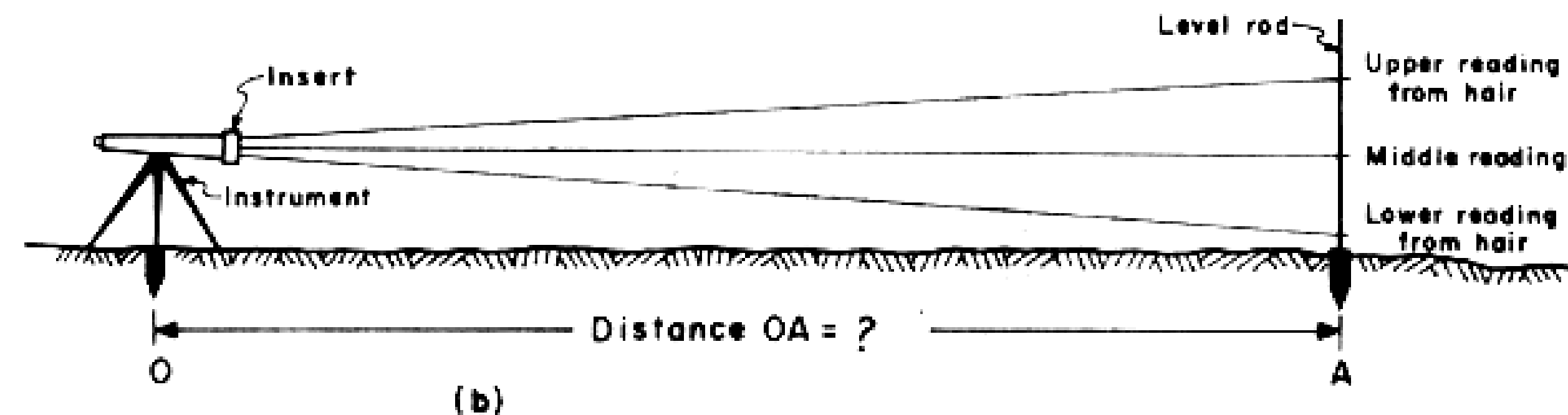


Optical Distance Measurement (ODM)

Optical instruments: levels and theodolites can be used to measure horizontal distances.



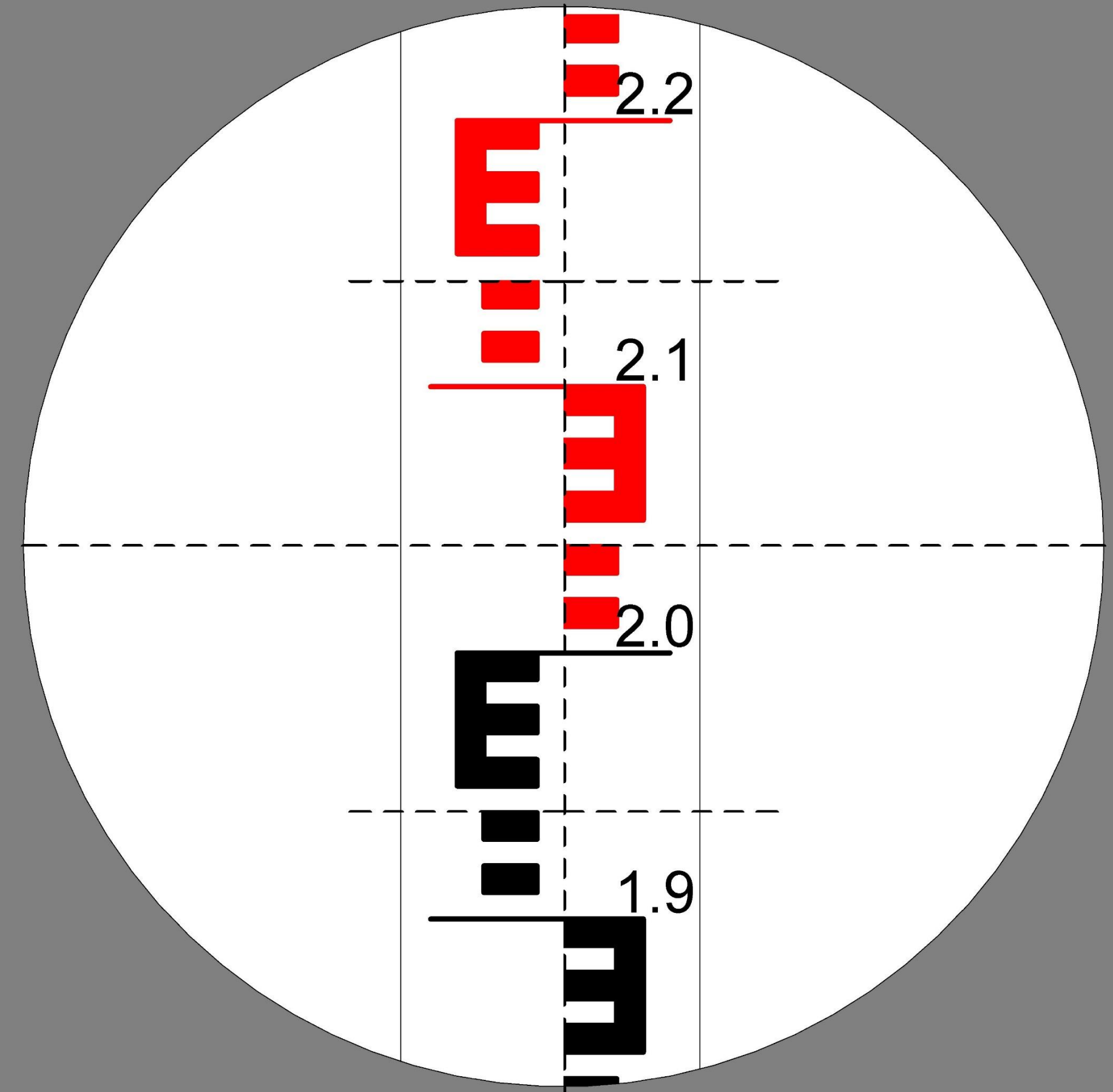
(a) Insert - Intersection of stadia hairs and level rod as seen in the telescope



How to measure distances by the stadia method

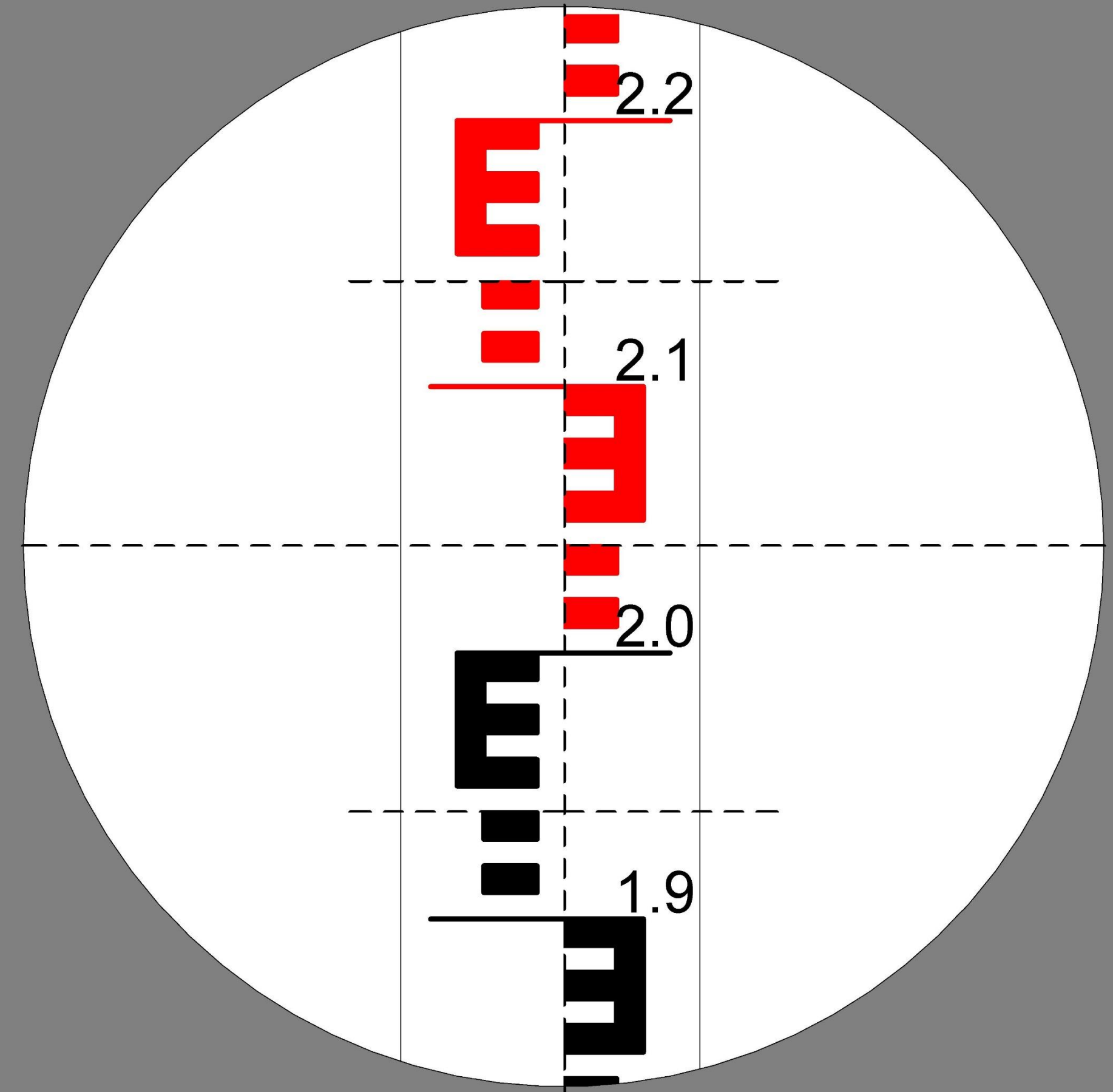
The stadia method is rapid and accurate for measuring long distances..

There are two extra horizontal hairs called stadia hairs on the telescope. Most surveyor's levels have these stadia hairs at an equal distance above and below the horizontal cross-hair. The difference between staff readings (Upper and Lower hairs) is called staff intercept, S .



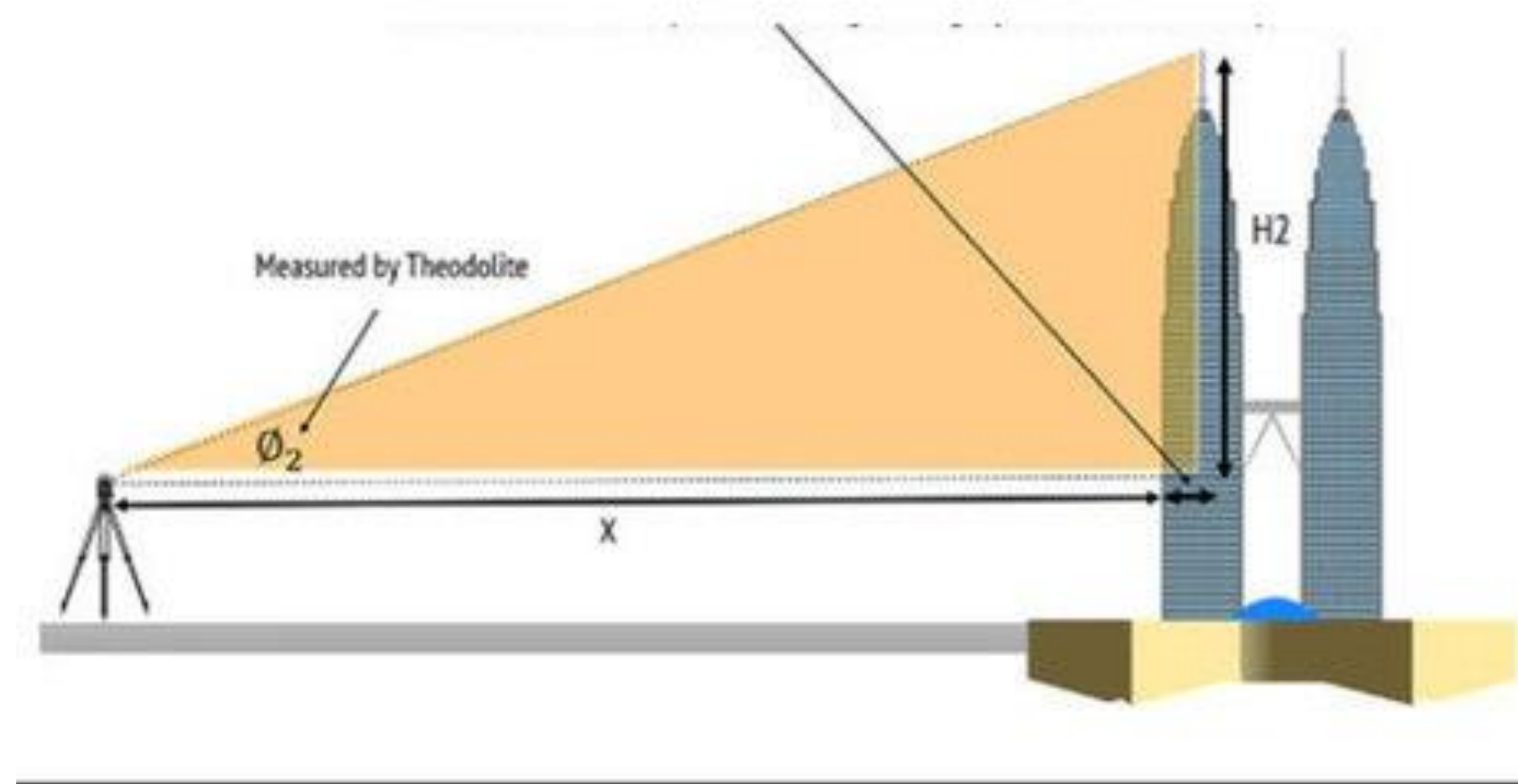
How to measure distances by the stadia method

- Horizontal distance = $S \times 100$
- Example
- Upper stadia hair reading: 2.14 m; Lower stadia hair reading: 1.94 m.
- Stadia interval = $2.14 \text{ m} - 1.94 \text{ m} = 0.2 \text{ m}$
- Stadia factor = 100; constant
- Distance AB = $0.2 \text{ m} \times 100 = 20 \text{ m}$.



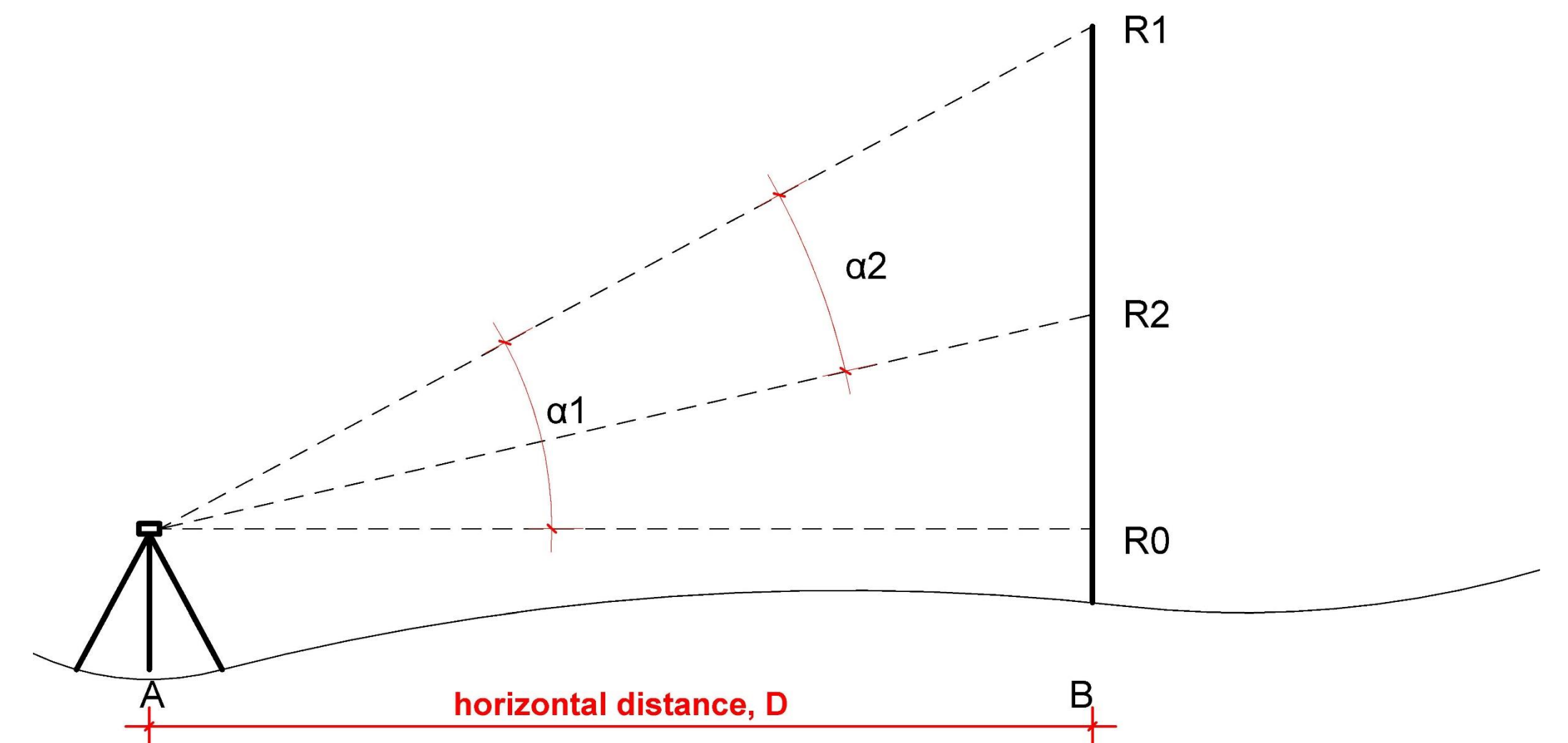
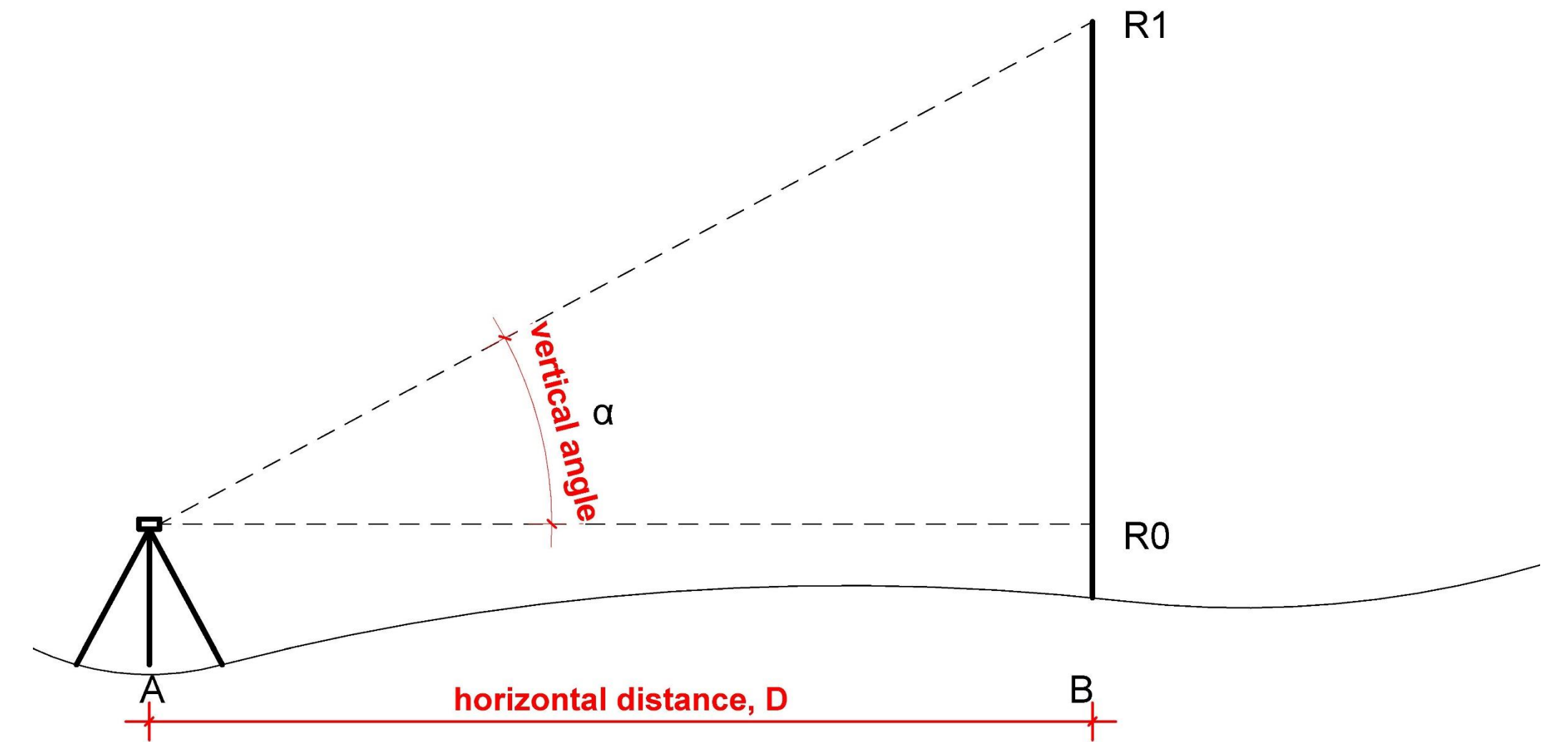
How to measure distances by theodolite

- Vertical angles measured by theodolite can be used to determine horizontal distances.



How to measure distances by theodolite

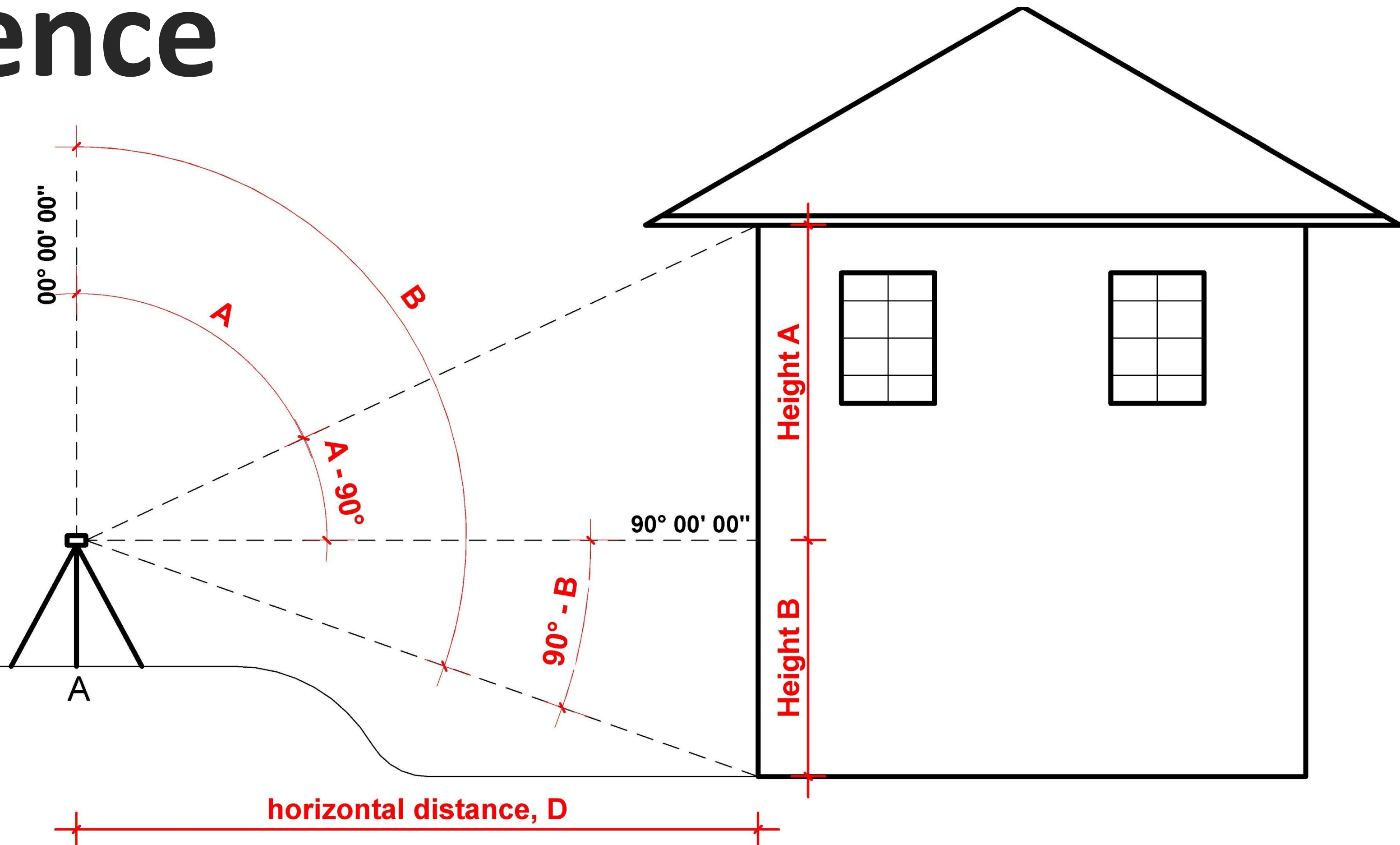
- $AB = D = (R1 - R0) / \tan \alpha$
- $AB = (R1 - R2) / (\tan \alpha1 - \tan \alpha2)$



Vertical Angle and Height Difference

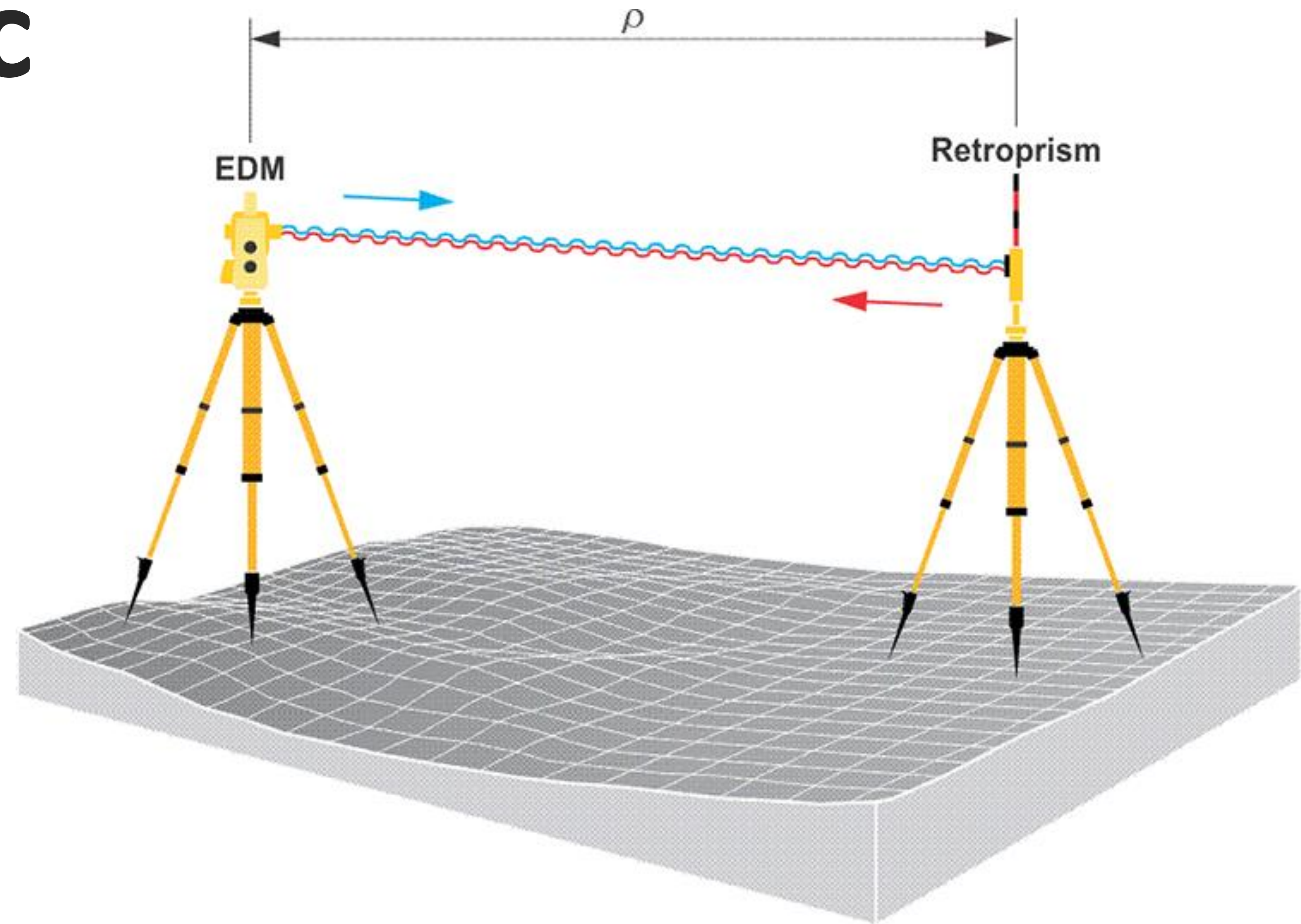
- Height A = horizontal distance x $\tan 90^\circ - A^\circ$

- Height B = horizontal distance x $\tan B^\circ - 90$



Electromagnetic Distance Measurement (EDM)

EDM instruments are available to measure distance using light, micro and radio waves. The distance is calculated either from the time difference between a transmitted pulse and a return pulse or the phase difference between a transmitted and a reflected beam of radiation.



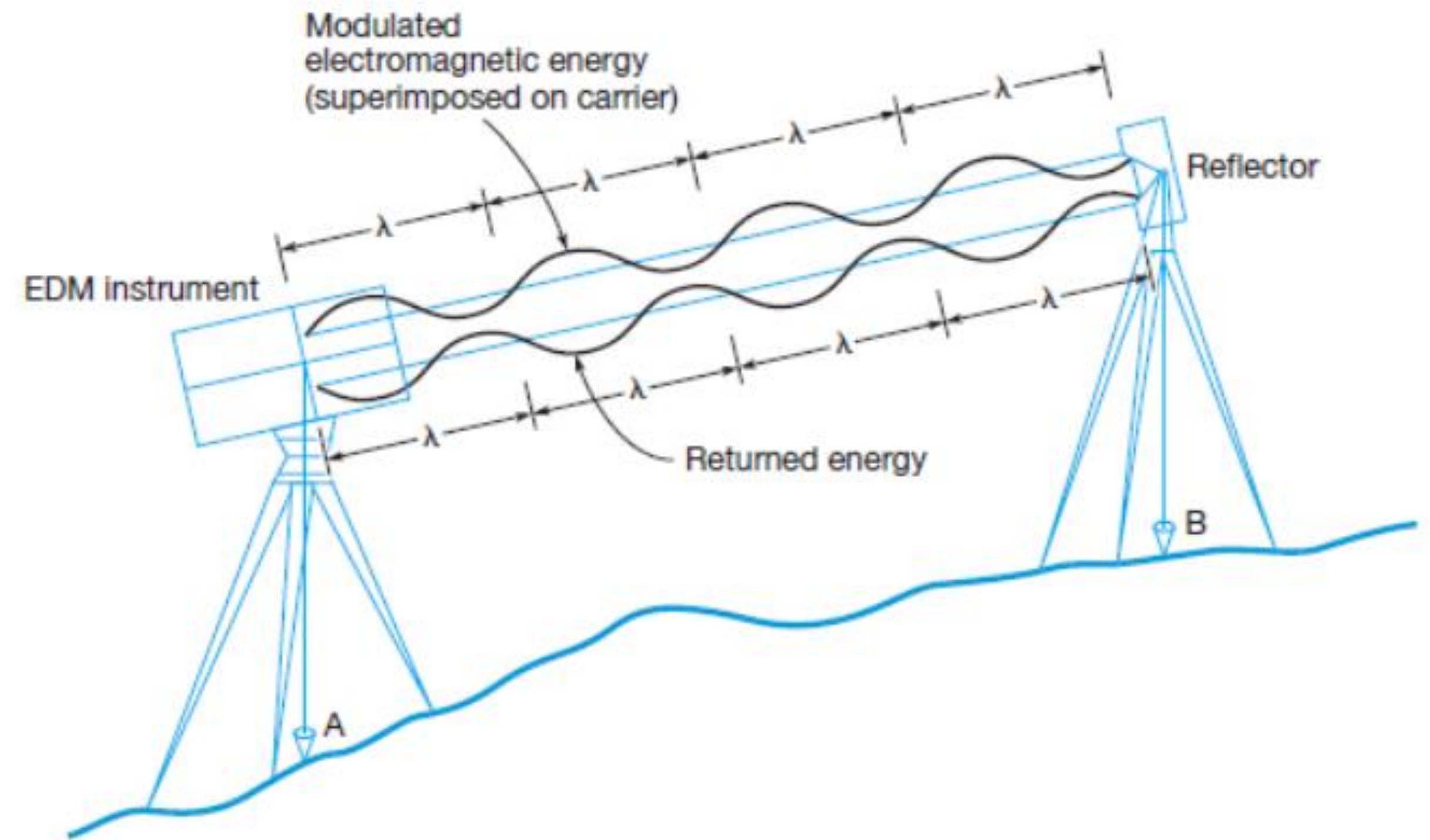
Electromagnetic Distance Measurement (EDM)

The system is composed of two units: the main transmitting/receiving unit and the receiving/reflecting unit (the reflector when using optical light electromagnetic waves).



Electromagnetic Distance Measurement (EDM)

- Double Distance = wave speed x time lapse = $v \times dt$
- Distance between EDM and Reflector cross = $v \times dt / 2$



Electronic Tacheometer

- When an EDM is used together with an electronic theodolite, the combination functions as an electronic tacheometer, later built in one instrument called Total Station



Total Station

- A Total Station integrates the functions of a theodolite for measuring angles, an EDM for measuring distances, digital data and information recording.

